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Safety Test Solutions

SignalShark 5G Analyzer V 1.0.0

The SignalShark 5G Analyzer consists of two measurement modules:

The 5G EMF Extrapolation module makes it possible to determine the average level of a 5G resource element (RE). For this purpose, a downstream with maximum power is requested using a suitable user equipment (e.g. a smartphone). The SignalShark 5G Analyzer records an isotropic spectrogram and calculates the average level of a 5G resource element as well as the extrapolated maximum channel level.

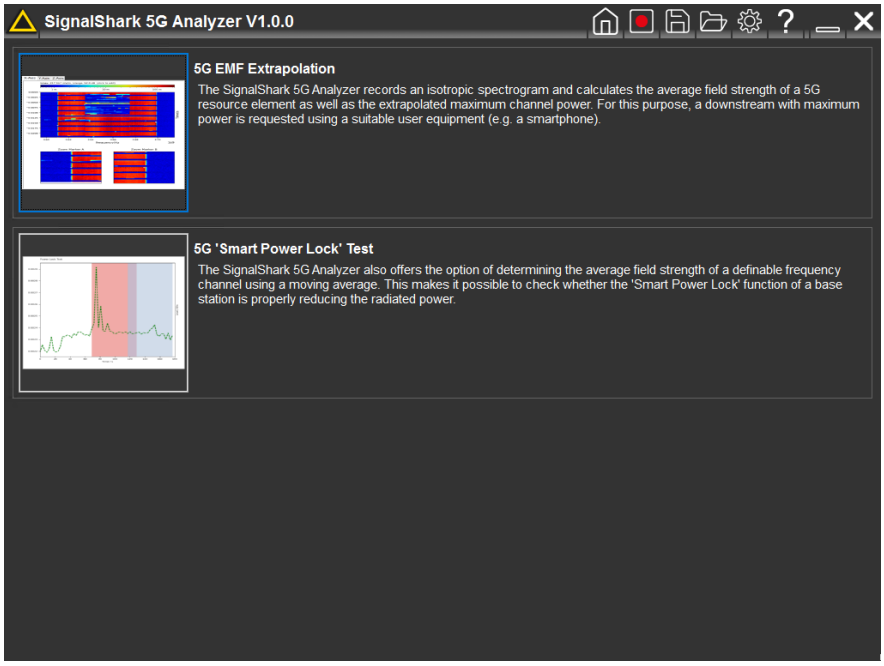
The SignalShark 5G Analyzer also provides a 5G 'Smart Power Lock' Test module with which the average level of a definable frequency channel can be determined using a moving average function.

This Quick Guide explains how to install and activate the SignalShark 5G Analyzer software and it describes its views and how to operate the two measurement modules step-by-step.

Views

Main View

The main view of the SignalShark 5G Analyzer shows the two measurement options for EMF Extrapolation and for Smart Power Lock Testing.



The icons shown in the upper right corner of the main view are briefly explained by the table below:

Icon	Function
	**Home** Return to Main View.
	**Start Measurement** Starts a measurement (only when measurement module has been selected and a valid license is available).
	**Save** Saves the measurement including all settings and screenshots for documentation purposes. For systems with multiple monitors, the application must be placed on the main screen (Display 1) to save data so that the screenshots are displayed correctly.
	**Load** Loads a measurement for post analysis (only when measurement module has been selected).
	**Settings** Opens the settings dialog.
	**Help** Opens the help dialog.
	**Minimize** Closes the main view and opens a minimal view. The minimum view enables the display of a spectrogram measurement and manual adjustment of the antenna axes. This gives the possibility to observe the current channel utilization. A 5G measurement can also be started in the minimum view.
	**Close** Closes the application.

Minimum View

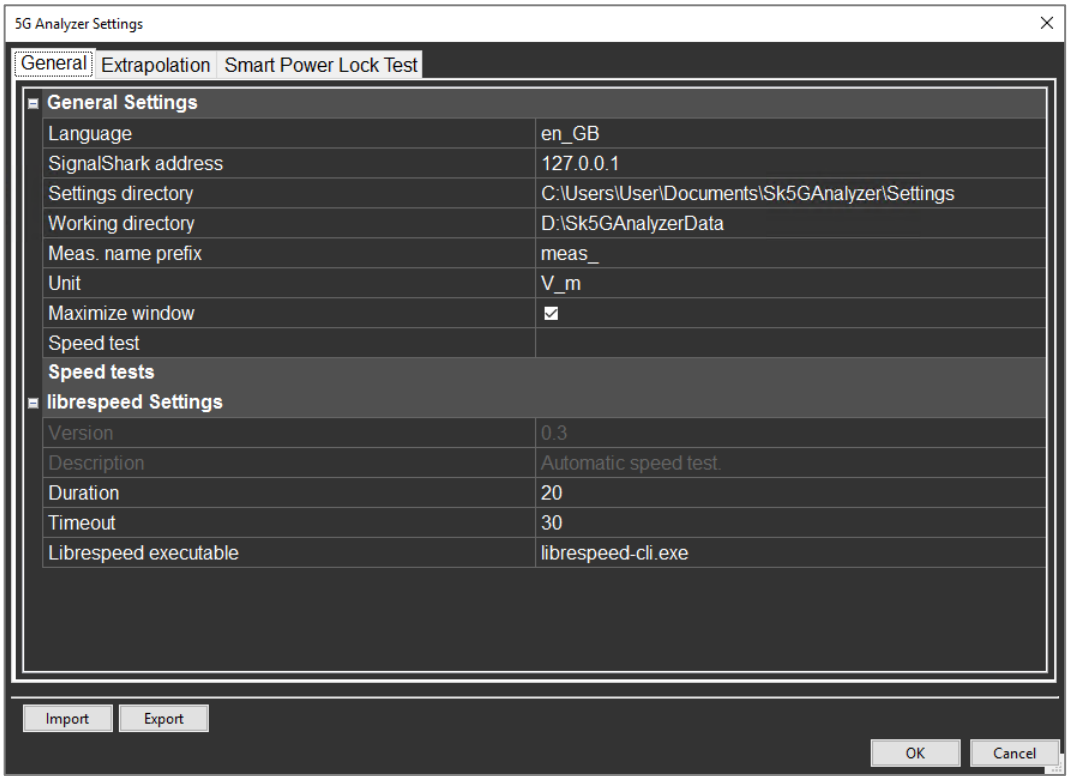
The 5G Analyzer application can be minimized so that the SignalShark main user interface becomes visible in the background. Within the minimum view the 5G Analyzer application still allows for switching the antenna axis. This gives the possibility to observe the current channel utilization via the SignalShark main user interface. Also a 5G measurement can be started in the minimum view.

Icon	Function
	**Enlarge** Enlarges from Minimum View back to Main View or selected measurement module
	**Start Measurement** Starts a measurement.
	**Manual Axis Selection** An axis for manual live measurement can be selected here.

Settings Dialog

In the Settings Dialog various settings can be made as further explained below:

General Settings



Language:

The language for the user interface can be set here. The setting becomes active after restarting the application.

SignalShark address:

If the application is running on the SignalShark, the IP address should be set to '127.0.0.1'. If the application is running on a PC, the IP address of a SignalShark connected to the PC can be specified to control it.

Settings directory:

Default directory for exporting and importing settings.

Working directory:

Working directory in which the measurements are saved.

Meas. Name prefix:

Prefix which is placed in front of the suggested file name during automatic generation.

Unit

The measurement results can be displayed in V/m, W/m² and dBµV/m.

Maximize window:

If the box is ticked, the measurement window is maximized when it is opened.

Speed Test:

To make the measurement as user-friendly as possible, there is the option of an automated speed test to get maximum download traffic. If a speed test is selected, it is automatically applied during the measurement. The speed tests have been created as a plug-in concept so that the users also have the option of using their own tests.

As a first example, the open-source test "LibreSpeed" was implemented. To use the test, connect the SignalShark to a 5G-capable Android phone via the USB 3.0 port (on top of SignalShark handheld unit) and activate USB tethering on the Android device. After

selecting "librespeed" in the 5G Analyzer software settings, the speed test is executed automatically when a 5G EMF Extrapolation measurement is started. The plugin is provided as a simple example.

Speed tests

Librespeed Settings

Version:
Current version of speed test (here: of Librespeed test)

Description:
Description, particularly if multiple speed tests are used and differ in behavior.

Duration:
Speed test duration. The default value is ’20 seconds’.

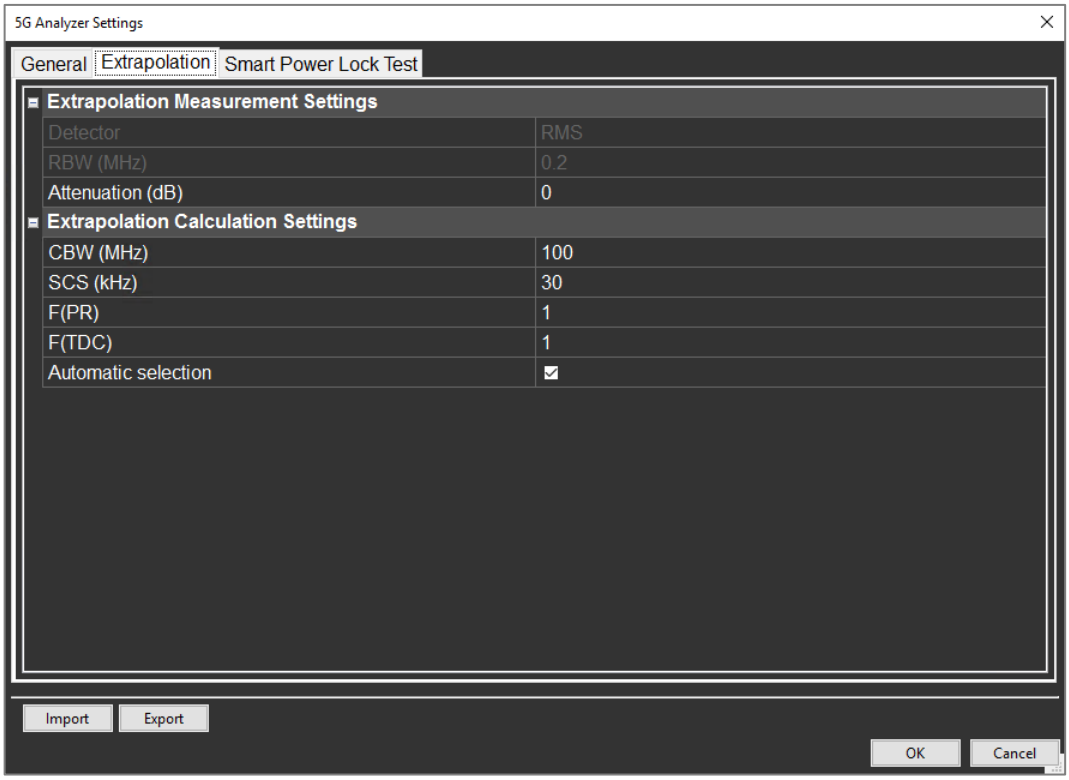
Timeout:
Timeout time after which the measurement is aborted if the plugin does not respond. The default value is ’30 seconds’.

Librespeed executable:
Path to the executable file of Librespeed. The default path is ‘C:\Program Files (x86)\LibreSpeed\librespeed-cli.exe’

Import and Export of Settings

Settings can be saved and reloaded as an XML-based file using the Export and Import buttons.

Extrapolation Settings



Extrapolation Measurement Settings:

The settings below apply to the 5G EMF Extrapolation data acquisition. The measurement settings cannot be changed after a measurement has been completed, as they influence the measured value acquisition.

Detector:

The system uses the RMS detector to measure values.

RBW (MHz):

A Resolution Bandwidth (RBW) of 0.2 MHz (= 200 kHz) is used for the acquisition of measurement values.

Attenuation (dB):

Allows you to specify an attenuation value if the system was overdriven.

Extrapolation Calculation Settings:

The settings below apply to the 5G EMF Extrapolation calculation. The calculation values can also be adjusted after a measurement.

CBW (MHz):

The channel bandwidth (CBW) of the 5G signal to be measured.

SCS (kHz):

The subcarrier spacing (SCS) of the 5G signal to be measured. You can choose from 15 kHz, 30 kHz and 60 kHz.

F(PR):

The power reduction factor F_{PR} of the 5G signal to be measured. The default value is ‘1’.

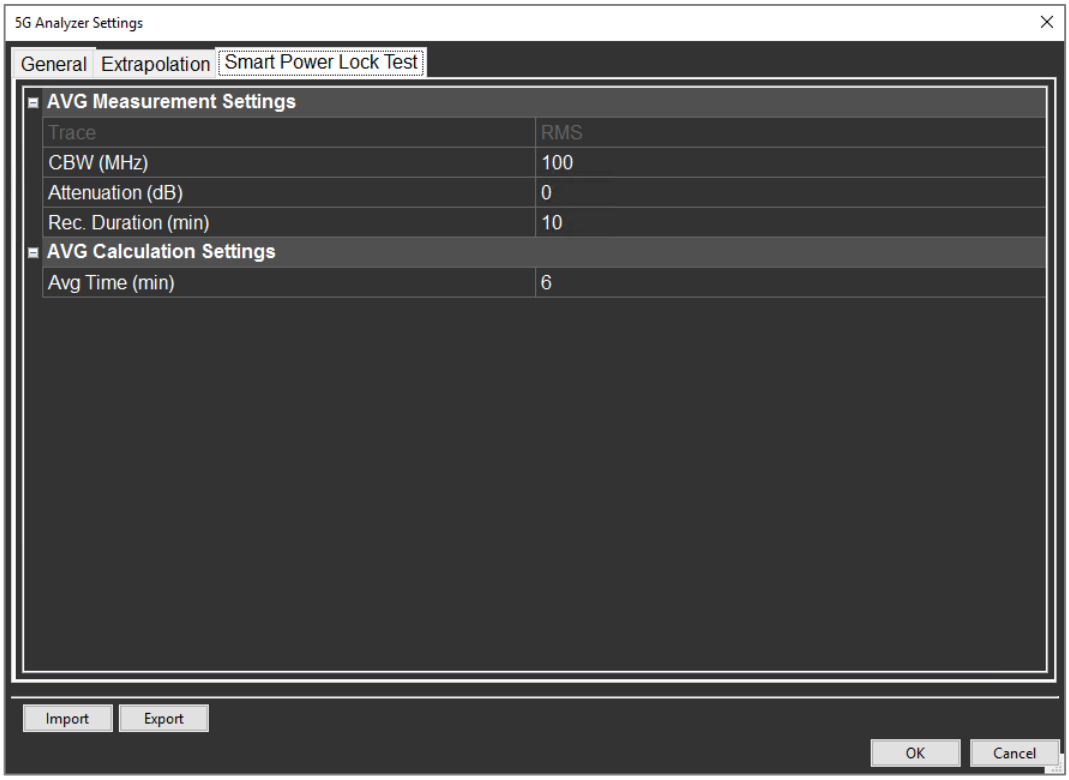
F(TDC):

Reduction factor F_{TDC} for the duty cycle between uplink and downlink.
The default value is ‘1, which would mean that all timeslots are downlink timeslots. In most cases, this would lead to an overestimation.

Automatic selection:

Automatically sets the marker areas to the areas of the strongest resource blocks. The markers can then be fine-tuned manually.

Smart Power Lock Test Settings



AVG Measurement Settings:

The settings below apply to the 5G Smart Power Lock Test data acquisition. The measurement settings cannot be changed after a measurement has been completed, as they influence the measured value acquisition.

Trace:

Trace or detector of the measurement. Default value is RMS.

CBW (MHz):

The channel bandwidth (CBW) of the 5G signal to be measured. Default value is 100 MHz.

Attenuation (dB):

Allows you to specify an attenuation value if the system was overdriven.

Rec. Duration (min):

The duration of the signal recoding in order to perform averaging. Default value is 10 minutes. The value should be greater than the Avg Time.

AVG Calculation Settings:

The settings below apply to the 5G Smart Power Lock Test calculation. The calculation values can also be adjusted after a measurement.

Avg Time (min):

Time for calculation of average value. Nominal value (as per standard) and default value: 6 minutes.

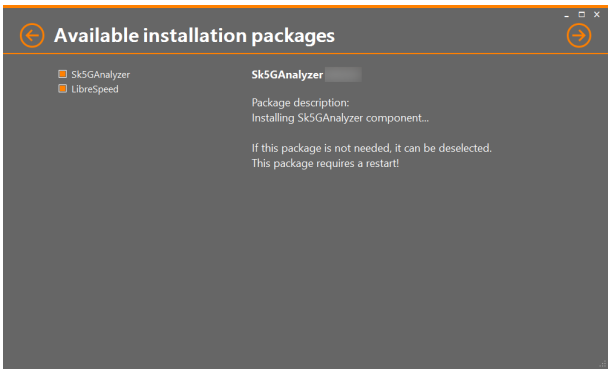
Installation

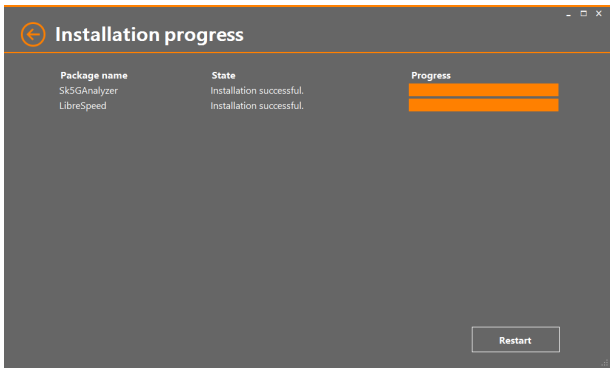
Installing SignalShark 5G Analyzer Software

The software can be installed on a PC or directly on a SignalShark.

After the archive file has been copied to the device/PC and unzipped, the installation can be started by executing the file "Sk5GAnalyzer_X.X.X.X.exe".

In the installation wizard that opens, select "Local Installation". The wizard will guide you through the entire process, including the installation of the program files, the necessary libraries and the required drivers.





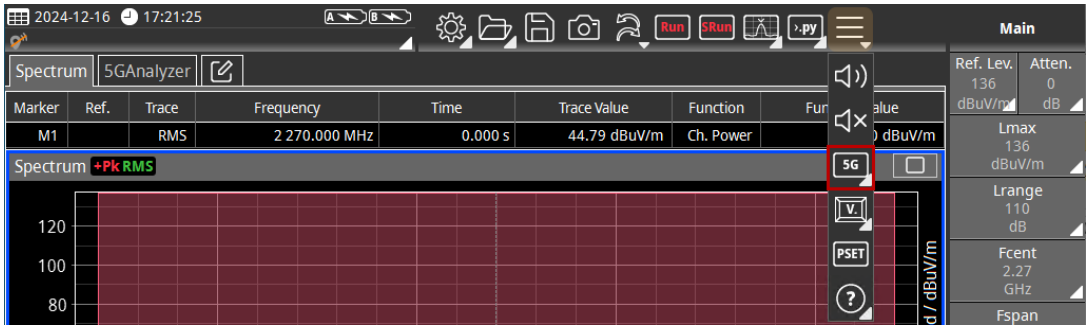
At the end of the installation, click on the 'Restart' button to reboot SignalShark.

Installing Option for Measurement Support

If you want to use the software to perform measurements, you must purchase the “3310/95.020 Option, SignalShark 5G Analyzer Measurement” and install it on the corresponding SignalShark. Without this option, you can load and analyze stored measurements. This can be used, for example, for evaluation purposes and to create measurement ranges.

Executing the SignalShark 5G Analyzer

To open the SignalShark 5G Analyzer, open the advanced functions menu in SignalShark and click the 5G button. On your PC, you can open the SignalShark 5G Analyzer by double-clicking the desktop shortcut.



Operation

Operating 5G EMF Extrapolation

Introduction

The SignalShark 5G Analyzer makes it possible to determine the average level of a 5G resource element (RE) and to extrapolate it to the entire signal. For this purpose, an isotropic antenna (3-axis-antenna) is connected to SignalShark.

When starting a measurement, the device records spectrogram data for the given frequency span and time duration (i.e. period length and number of periods) on all three antenna axes. The recorded data will then be displayed as a spectrogram per axis.

Within the recorded spectrograms the user can manually analyze the resource grid and set individual markers. In case of EMF measurements these markers will typically be set to moments of the strongest resource blocks. Based on the marker settings two calculations will be performed by the measurement module:

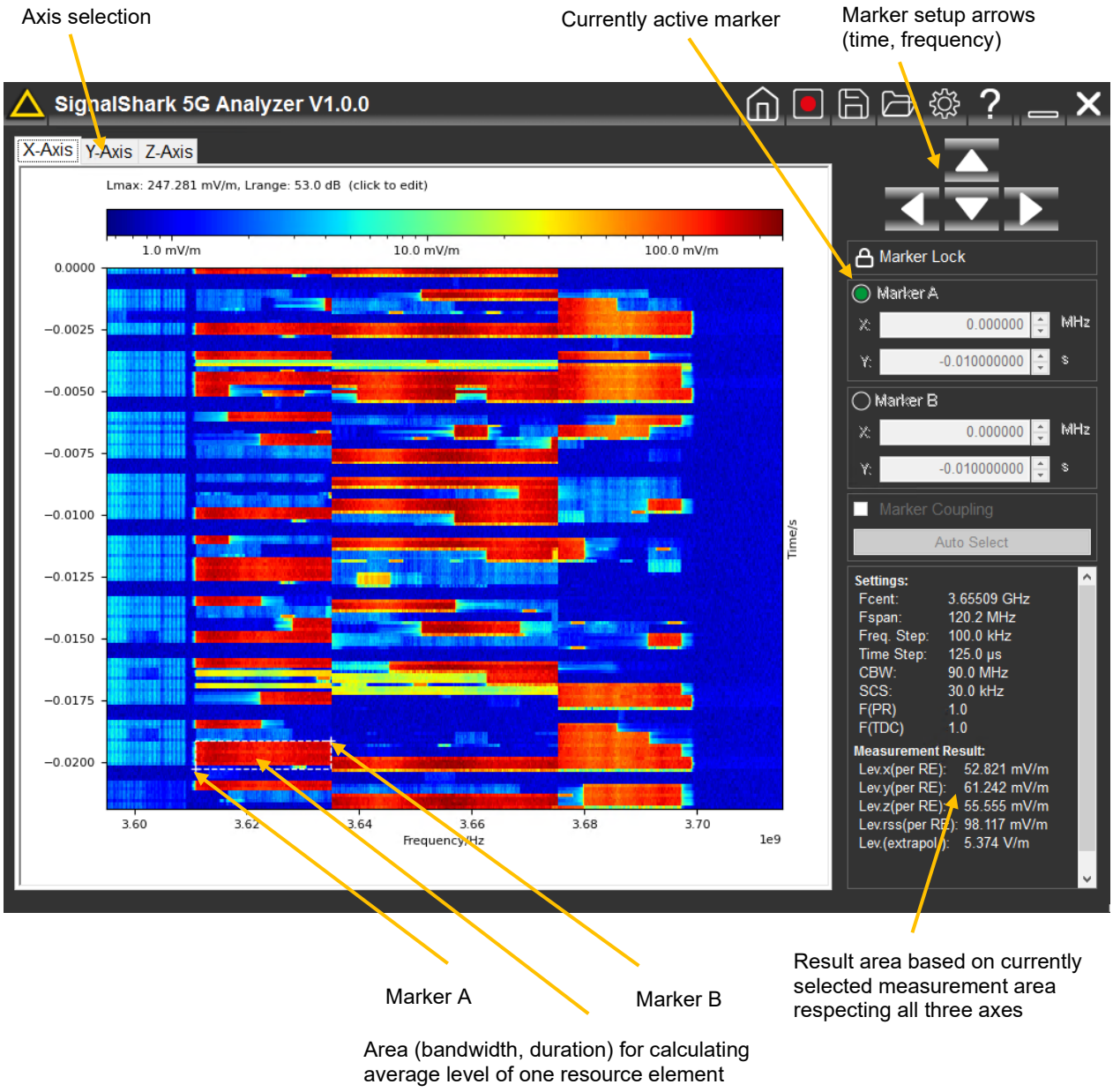
- The average level of one resource element within the marked area will be calculated (i.e. interpolated).
- The average level of the marked area will be extrapolated to the complete signal as defined in the settings.

As 5G may use extensive beamforming, it is essential that the above-mentioned measurement does not just represent ´any´ spatial measurement but that it represents a measurement where a 5G beam was pointing to the measuring unit. For this purpose, a downstream with maximum power needs to be requested. This can be achieved by using a suitable user equipment (e.g. a smartphone) that may work independently from the 5G Analyzer software. However, the software can also generate a downstream by means of a speed test which can be triggered simultaneously to the measurement and requires a suitable user equipment to be connected to SignalShark and using USB tethering for internet connectivity.

Data acquisition

1. Connect an isotropic antenna to the SignalShark.
2. In the SignalShark main user interface ensure that there is already one task (RT Spectrum or Scan Spectrum) running with any settings.
3. Open the SignalShark 5G Analyzer by pressing the 5G button in the main menu.
4. In the Main View select the 5G EMF Extrapolation module
5. Tap on the settings button to open the settings dialog and adapt the settings according to the 5G signal to be measured, see also sections 1.3.2 and 0 for details.
6. If you have selected the automatic speed test ‘librespeed’ in the settings, connect the SignalShark to a 5G-capable Android phone via the USB 3.0 port (on top of SignalShark handheld unit) and activate USB tethering on the Android device. Make sure that the USB tethering is working properly, an appropriate RNDIS network is available and that your mobile phone contract supports 5G and provides sufficient data volume.
7. Tap on the ‘Start Measurement’ button (red recording icon in top tool bar).
8. In the pop-up window, enter the center frequency and select the frequency span. The span should be larger than the channel bandwidth of the 5G signal. The center frequency can also be read from the device if a 5G task is already present and properly configured. Then press ‘OK’.

9. Wait until the measurement is finished.
10. After the measurement has been finished, a result as exemplarily shown below may be displayed. See following chapters for further details.



Additional marker settings:

Marker Lock:
Will lock markers to not reset them, e.g. by mistake (consider touchscreen in SignalShark Handheld)

Marker Coupling:
Will couple all markers from the three axes (typically not in used as measurements on axes run sequentially)

Auto Select:
Will automatically search for maximum within resource grid for all three axes.
The automatically determined range is only a selection aid and must be checked manually!
If, for example, the UE (test smartphone) signal is stronger than the signal of the base station, resource elements from the uplink will be selected.

Set marker range and save results

As indicated on the previous page, Marker A and B are used for determining the interpolated and extrapolated result level values. For handling the two markers, follow the procedure below:

1. Click on the 'X-Axis' tab to select the spectrogram for the X-axis measurement.
2. Select the largest possible area with maximum download traffic in the spectrogram with the markers. To do this:
    a. click on the 'Marker A' button and then on the bottom left-hand corner of the area in the spectrogram.
    b. Then click on the 'Marker B' button to define the top right-hand corner of the marker area in the same way. You can use the arrow keys (buttons and hard keys) to fine-tune the marker position. Press the OK button to switch between marker A and marker B.
3. Now switch to the next tab 'Y-Axis' and check whether the marker range you have just defined also fits here.
4. If the downlink does not fill the entire marker area, uncheck the 'Marker Coupling' checkbox and adjust the marker range for the Y-axis accordingly as described above.
5. Proceed accordingly for the 'Z-Axis' tab.
6. Check the marker ranges for all three axes again.
7. Finally, check the results (see next chapter) and save the measurement with disk icon in the toolbar. This also automatically creates screenshots for documentation purposes.

Read out result

The measured values and the extrapolated channel level can now be read in the results panel.

The setting for the extrapolation can also be adjusted after the measurement if required. To do this, click on the ‘Settings’ button or in the results panel.

Lev.x(per RE):
Received level per resource element for the X-axis in actual unit.

Lev.y(per RE):
Received level per resource element for the Y-axis in actual unit.

Lev.z(per RE):
Received level per resource element for the Z-axis in actual unit.

Lev.rss(per RE):
Isotropic received level per resource element (i. e. RMS of all axes) in actual unit.

Lev.(extrapol)
Extrapolated level for the 5G signal (i.e. Erss extrapolated to CBW) in actual unit.

Recall result

In the 5G Analyzer software it is also possible to recall results from the past. To do this, you must first select the correct measurement module in the software. After that, click on the directory icon in the top tool bar and select the desired file. In case of the measurement module EMF Extrapolation the file format must be `.sk5csv`. The displayed measurement can now be handled as if it has just been recorded.

Operating 5G ‘Smart Power Lock’ Test

Introduction

‘Smart Power Lock’ is the ability of a 5G base station to temporarily exceed level levels (typically for a certain beam) so that the average allowed level (typically over the last six minutes as per EMF measurement standard) is still below the allowed maximum.

With the 5G Smart Power Lock Test measurement module in the SignalShark 5G Analyzer, it is possible to monitor the RMS channel power of a 5G signal over several minutes and to calculate a moving average over a definable time (typically six minutes). During the measurement, the software automatically determines the maximum average level value. This value can then be compared with the EMF limit values.

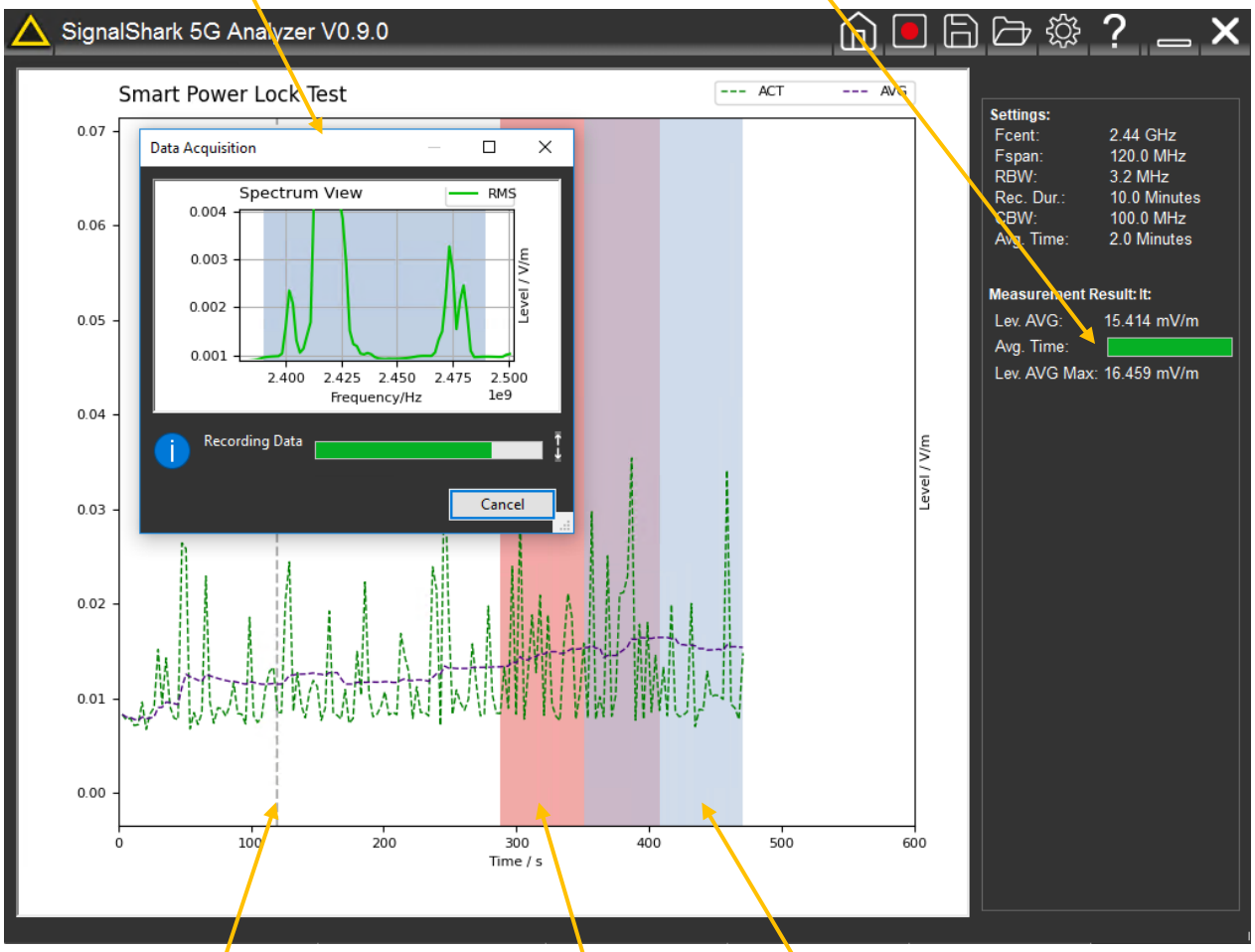
As 5G may use extensive beamforming, it is essential that the above-mentioned measurement does not just represent ´any´ spatial measurement but that it represents a measurement where a 5G beam was pointing to the measuring unit. For this purpose, a downstream with maximum power needs to be requested. This can be achieved by using a suitable user equipment (e.g. a smartphone) that may work independently from the 5G Analyzer software.

Data acquisition

1. Connect an isotropic antenna to the SignalShark.
2. In the SignalShark main user interface ensure that there is already one task (RT Spectrum or Scan Spectrum) running with any settings.
3. Open the SignalShark 5G Analyzer by pressing the 5G button in the main menu.
4. In the Main View select the 5G Smart Power Lock Test module
5. Tap on the settings button to open the settings dialog and adapt the settings according to the 5G signal to be measured, see also section Settings for details.
6. Tap on the ‘Start Measurement’ button (red recording icon in top tool bar).
7. In the pop-up window, enter the center frequency and select the frequency span. The span should be larger than the channel bandwidth of the 5G signal. The center frequency can also be read from the device if a 5G task is already present and properly configured. Then press ‘OK’.
8. Wait until the measurement is finished.
9. While the measurement is running and after the measurement has been finished, results as exemplarily shown on the following pages may be displayed. With regards to these measurement examples, the following notes shall be considered:
    a. While the measurement is running, an additional window is displayed showing the current isotropic RMS spectrum and the selected channel bandwidth. This window can be moved if necessary, but it will be displayed as the topmost window.
    b. The red area in the main diagram is set automatically indicating the maximum average. The width of this area is defined by the averaging time.
    c. The blue area in the main diagram displays the current basis for averaging. It moves forward while the measurement is running and it can be moved manually by drag & drop when the measurement has been finished.
    d. The green bar on the right side indicates when the full averaging time has been reached.
    e. The green ACT trace in the main diagram displays the current isotropic RMS level related to the defined CBW (i.e. integration of RMS spectrum)
    f. The violet AVG trace in the main diagram displays the moving average isotropic RMS level related to the defined CBW and to the defined averaging time. The peak of that trace serves as reference for the red area, supposing the averaging time has been fully reached.

Data Acquisition window displays currently measured spectrum including CBW (blue channel); window can be moved

Green bar indicates when full averaging time is active (here two minutes)

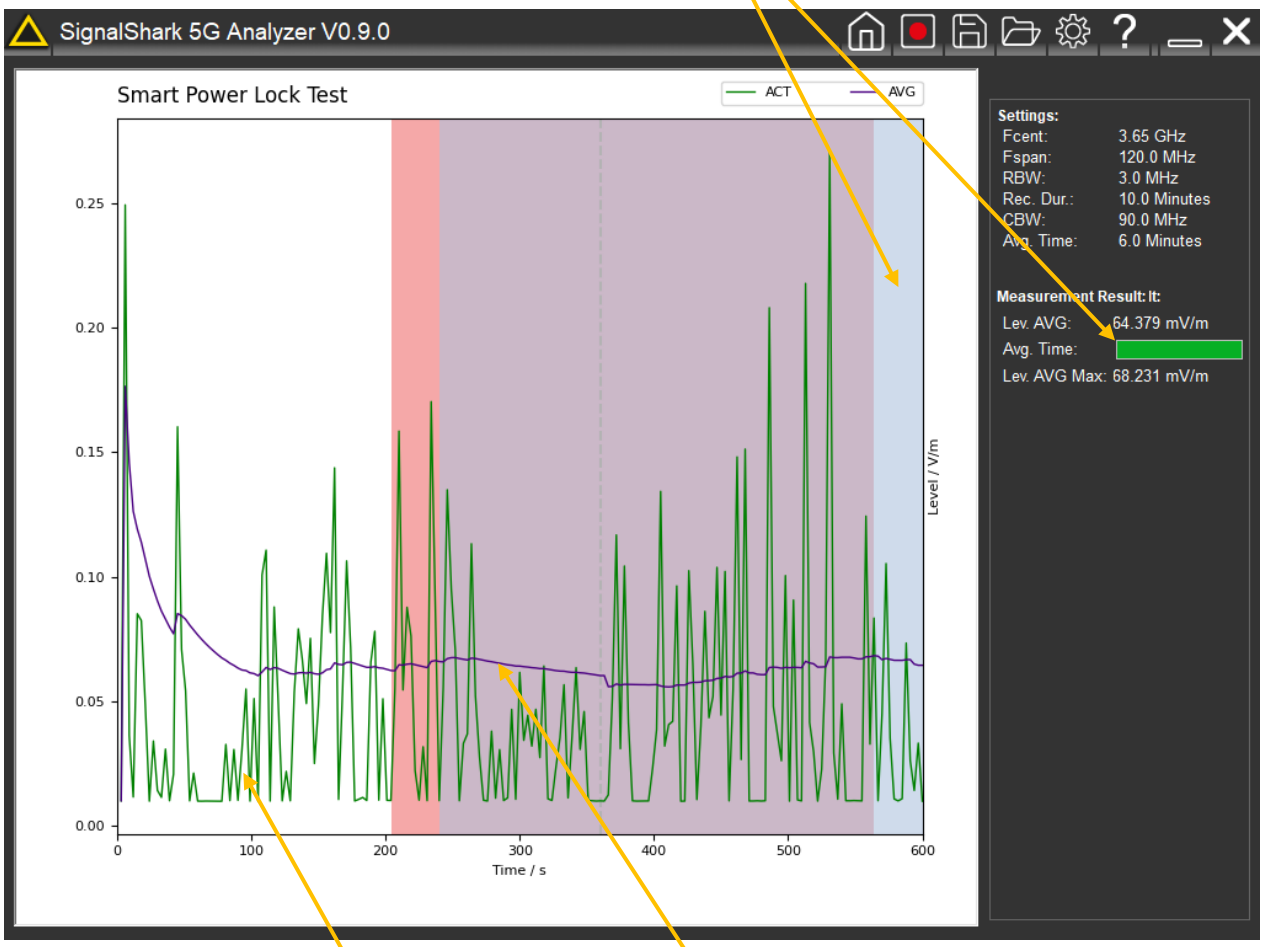


Indicates averaging time related to zero. From this time on, the purple trace shows valid data based on the moving average.

Red window indicates automatically determined measured maximum average; level indicated by 'Lev. AVG MAX'

Blue window indicates current basis for averaging and moves while measurement is running; level indicated by 'Lev. AVG'

Blue channel can be moved by drag & drop after measurement has been finished for manual maximum analysis (compare with ‘Lev. AVG’)



Green ACT Trace indicates current measurement values, i.e. channel level for defined CBW

Violet AVG Trace indicates current average measurement values, i.e. average channel level for defined CBW related to averaging time

Set averaging range

As already mentioned the blue area in a finished Smart Power Lock Test measurement can be moved over time for individual measurement purposes. To do so, drag and drop the blue area in the diagram and compare with the result ‘Lev. AVG’.

Read out result

The maximum average level for the configured CBW and averaging time can be read in the results panel.

The averaging time setting can also be adjusted after the measurement if required. To do this, click on the ‘Settings’ button.

Lev. AVG Max:
Automatically determined isotropic maximum average level over defined CBW and averaging time.

Recall result

In the 5G Analyzer software it is also possible to recall results from the past. To do so, first in the software the proper measurement module must be selected. After that, click on the directory icon in the top tool bar and select the desired file. In case of the measurement module Smart Power Lock Test the file format must be `.sk5acsv`. The displayed measurement can now be handled as if it has just been recorded.

Required Software Options

Software Option	Part number
Option, Spectrogram	**3310/95.002**
Option, SCPI Remote Control	**3310/95.012**
Option, SignalShark 5G Analyzer Measurement	**3310/95.020**

Recommended Accessories

Accessory	Part number
Antenna Holder for Triaxial Antenna	**3501/90.02**
RF-Cable, 9kHz-6GHz, 5m, N 50 Ohm	**3602/02**
Tripod, Non-Conductive, 1.65 m with carrying bag	**2244/90.31**
Tripod Extension, 0.50m, Non-Conductive	**2244/90.45**

Antennas	Part number
Antenna, Three-Axis, E-Field, 200 MHz – 6 GHz	**3502/02**

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